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New species of *Tygarrup* centipedes from Xizang, China (Geophilomorpha, Mecistocephalidae)

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Abstract

Prior to this study, the genus *Tygarrup* Chamberlin, 1914, is known to contain only two species in Xizang, China. New records derived from multiple collections allow for the distribution ranges of six species to be refined: *Tygarrup tridentatus* Jiang & Huang, **sp. nov.**, *Tygarrup cerrus* Jiang & Huang, **sp. nov.**, *Tygarrup multiporus* Jiang & Huang, **sp. nov.**, and *Tygarrup fimbriatus* Jiang & Huang, **sp. nov.** are described as new. *Tygarrup muminabadicus* Titova, 1965, was first reported in the fauna of Xizang. *Tygarrup poriger* (Verhoeff, 1942) is rediscovered and redescribed, and *Tygarrup nepalensis* Shinohara, 1965 is synonymized with *T. poriger*. Remarks are provided for all encountered species, and a key to all *Tygarrup* species in China is presented.

Key Words

Biodiversity, key, new record, taxonomy

Introduction

Xizang, the second largest provincial administrative unit of China, is located in the western and southern parts of the Tibetan Plateau. This region, known as the "third pole of the earth," is the highest place in the world. Its southern region, the Himalaya, exhibits a pronounced vertical stratification of ecosystems and is recognized as a biodiversity hotspot for the study of animal taxonomy as well as biological evolution (Cai et al. 2018; Li et al. 2022). A century ago, seventeen centipede species have been documented in Xizang, comprising eight species of Scolopendromorpha and seven species of Lithobiomorpha (Lewis 2010; Song et al. 2010; Ma et al. 2014; Qiao et al. 2019; Niu et al. 2021; Chen et al. 2023). However, understanding of the soil centipede species diversity in Xizang remains quite limited. To date, only two species of Geophilomorpha have been described from the region, both of which belong to the genus *Tygarrup* Chamberlin, 1914 (Silvestri 1919; Verhoeff 1942). This includes the incompletely described species *T. diversidens* (Silvestri, 1919) from the Himalayas and *T. poriger* (Verhoeff, 1942) from "the middle Himalaya," near Shigatse. The objective of the present study is to enhance our knowledge of the species diversity within Geophilomorpha in Xizang, with a focus on the discovery and description of new species of *Tygarrup* centipedes.

The genus *Tygarrup*, characterized by its elongated head capsule, clypeus with an entire plagula, spiculum absent, clypeal pleurite without setae, coxosternum of the first maxillae divided, whereas that of the second maxillae is undivided, and the sternal typically with pores present in males (Uliana et al. 2007). It is the second largest genus in the family Mecistocephalidae Bollman, 1893, and comprises 15 known species (Uliana et al. 2007; Bonato et al. 2011; Chao et al. 2020). This genus is mainly distributed

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in the tropical and subtropical regions of East Asia and Southeast Asia and can adapt to a variety of climates ranging from tropical rainforests to cold high mountains (Silvestri 1919; Verhoeff 1939, 1942; Paik 1961; Uliana et al. 2007; Bonato et al. 2011; Chao et al. 2020). Before this study, only three species of *Tygarrup* had been documented in China, with two species being restricted to Xizang (Silvestri 1919; Verhoeff 1942; Chao et al. 2020).

During our examination of *Tygarrup* specimens from Xizang, we identified six species within the genus, including four new species. In this study, we describe these species, with a particular focus on the new species.

Materials and methods

Specimens were collected by tweezers and preserved in 75% ethanol. The type materials are deposited in the National Resource Center for Chinese Materia Medica, China Academy of Chinese Medical Sciences, Beijing, China (CMMI).

Specimens were dissected, and their cephalic capsules, forcipular segments, mandibles, maxillary complexes, and remaining bodies were mounted on temporary slides using 75% ethanol or lactic acid. Taxonomic characters were examined and photographed (Figs 1, 2) using a Leica M205 FCA stereomicroscope (7.8–160×) and an Olympus BX51 microscope (100–400×). Photos were converted into hand-drawn illustrations using Sketchbook 6.0.6. Localities were mapped with ArcMap 10.7.1. The terminology of morphology follows Bonato et al. (2010a).

Results

Taxonomy

Order Geophilomorpha Pocock, 1895
Family Mecistocephalidae Bollman, 1893

Genus *Tygarrup* Chamberlin, 1914

Type species. *Tygarrup intermedius* Chamberlin, 1914, by original designation.

Diagnosis. See Uliana et al. (2007).

***Tygarrup tridentatus* Jiang & Huang, sp. nov.**

https://zoobank.org/4201B13D-F951-465C-894D-450027BCB860

Figs 1A–C, 3

Material examined. ***Holotype.*** • ♀ (CMMI 20240725001D), China, Xizang Autonomous Regions, Yadong County, Xiasima town (27.4788°N, 88.9063°E), 2960 m asl., 25.vii.2024, leg. Chao Jiang.

Paratypes. • 4♀♀ 3♂♂ 3 juveniles (CMMI 20230720002D, CMMI 20230725002D, -003D), same as holotype but collected at 20–25.vii.2024.

Other materials. • 2♀♀ 1♂ 1 juvenile (CMMI 20240721001D, 20240724001D), China, Xizang Autonomous Regions, Yadong County, Pangda village, 2100–2400 m asl., 21–24.vii.2024, leg. Chao Jiang & Qing Li, 3♀♀ (CMMI 20240720001D), Upper Yadong village, G562 National Road (27.5481°N, 88.9998°E), 3460 m asl., 20.vii.2024, leg. Chao Jiang & Qing Li; • 1♀ 2♂♂ 5 juveniles (CMMI 20240715001D–005D), Cuona County, Lei Menba ethnic village, Lei Hydroelectric-power station (27.8196°N, 91.7462°E), 2490 m asl., 15.vii.2024, leg. Chao Jiang & Qing Li, 2♀♀ 4♂♂ (CMMI 20240714001D), Entrance of leibugou valley (27.9240°N, 91.8381°E), 3840 m asl., 14.vii.2024, leg. Chao Jiang; • 1♀ 1♂ (CMMI 20240714301D), Gongri Menba ethnic village, Mengyu Sanshenghu Lake (27.9267°N, 91.8728°E), 4410 m asl., 14.vii.2024, leg. Chao Jiang & Qing Li.

Diagnosis. A *Tygarrup* species with 45 leg-bearing segments. Body length of adult reaches 2.5 cm. Transverse suture curved. Clypeal setae 9–12 pairs. Forcipular trochanteroprefemur, tibia, and tarsungulum, each with a well-developed tooth, article II without teeth. Sternal pores present in males only.

Description. Maximum length of male 2.5 cm and female 2.3 cm.

Color (of preserved specimens in alcohol) morph 1: head and forcipular segment reddish-brown, trunk and legs homogeneously yellow, without dark patches (Fig. 1A–C, in Yadong populations); morph 2: head and forcipular segment dark red, trunk and legs yellow, with dark patches along the trunk, sternal sulci darker (in Cuona populations).

Cephalic plate 1.6 × longer than the widest. Transverse suture rounded. Lateral margins sinuous to straight, convergent backwards slightly, anterior margin convex, with a median incision, posterior margin slightly rounded (Fig. 3A).

Clypeus 1.9 × wider than long (Fig. 3B). Clypeus with an entire plagula covering most of the clypeus, areolation only present along the anterior margin of the head; clypeal setae as follows: 1 pair on the areolate part; 7–10 pairs along the anterior margin of the clypeal plagula, 1 pair on the central part of plagula (Fig. 3C).

Labrum (Fig. 3C): Mid-piece ca. 2 × longer than wide, posteriorly pointed and well sclerotized. Anterior ala triangular, and medial margin reduced to a vertex; posterior margin of each side-piece sinuous.

Cephalic pleurite without spiculum or setae; areolate part present along anterior margin and paraclypeal suture; stilus well-developed, nearly straight, with an anterior incision on each side (Fig. 3B).

First maxillae (Fig. 3D): Coxosternite 2 × wider than long, divided by mid-longitudinal suture, anterior corners of coxosternum not projecting. Medial projection about 1.5 × wider than long, internal margin with several setae, distal lobe curved inward; telopodite about 4 × longer than wide, curved inward.

Second maxillae (Fig. 3D): Coxosternite undivided, ca. 1.5 × wider than long; anterior and posterior margins concave, lateral margins concave medially, posterior corners only slightly projecting externally; areolation on medial part,

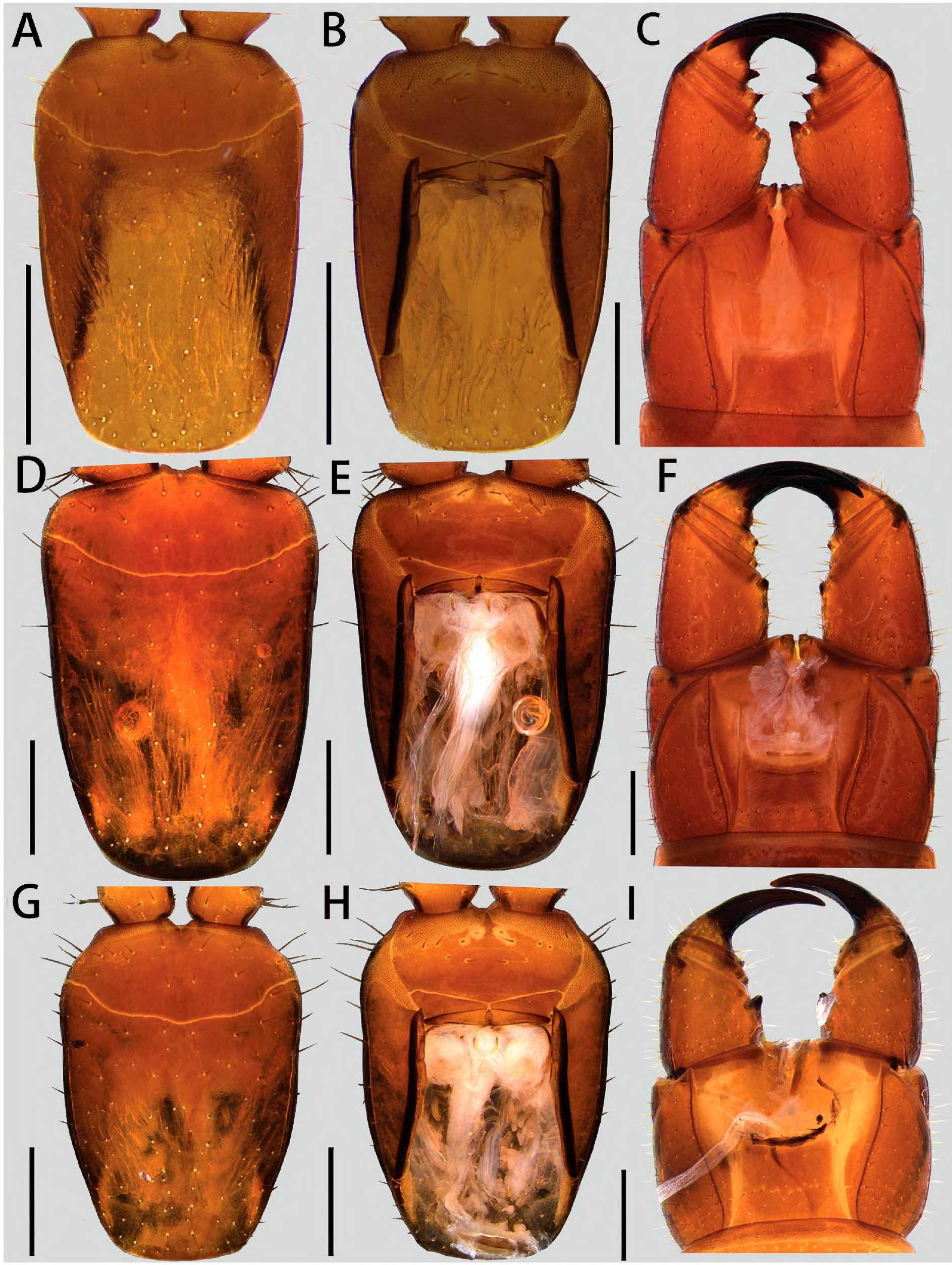

Figure 1. Cephalic plate and forcipular segments. **A, D, G.** Cephalic plates, dorsal; **B, E, H.** Cephalic plates, ventral; **C, F, I.** Forcipular segments, dorsal. **A–C.** *Tygarrup tridentatus* sp. nov., holotype; **D–F.** *Tygarrup cerrus* sp. nov., holotype; **G–I.** *Tygarrup multiporus* sp. nov., holotype. Scale bar: 500 µm.

with pores along the lateral margins, setae present along the posterior part. Foraminal process surrounding the metameric pore separated from lateral margin of coxosternite. Telopodites of the second maxillae well developed, surpassing those of the first maxillae; article 1 of telopodite ca. 4.7 × longer than wide, curved outward, with distal setae on

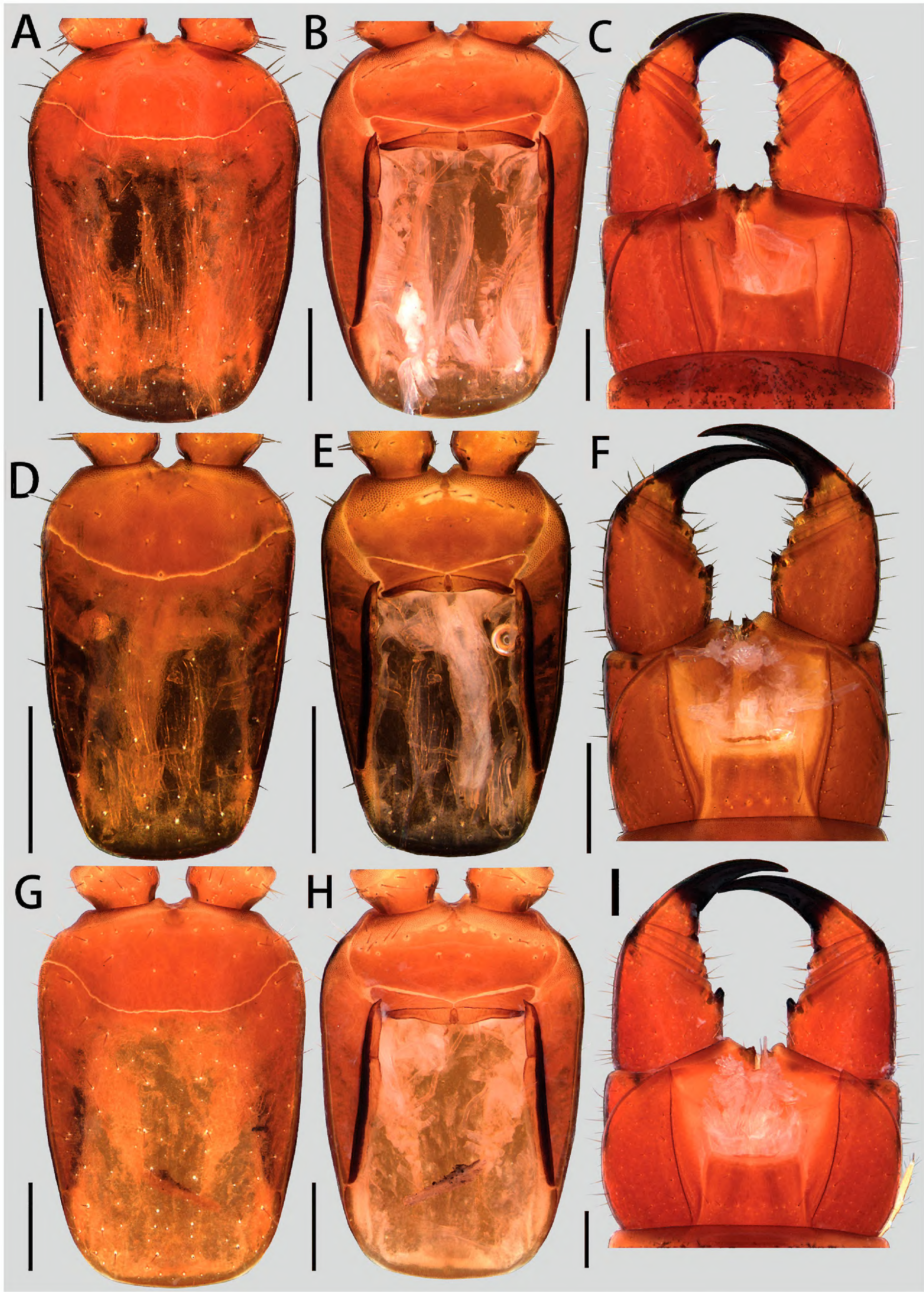

Figure 2. Cephalic plate and forcipular segments. **A, D, G.** Cephalic plates, dorsal; **B, E, H.** Cephalic plates, ventral; **C, F, I.** Forcipular segments, dorsal. **A–C.** *Tygarrup fimbriatus* sp. nov., holotype; **D–F.** *Tygarrup poriger* (Verhoeff, 1942) (spm. CMMI 20240309001D); **G–I.** *Tygarrup muminabadicus* Titova, 1965 (spm. CMMI 20240310001D). Scale bar: 500 μm.

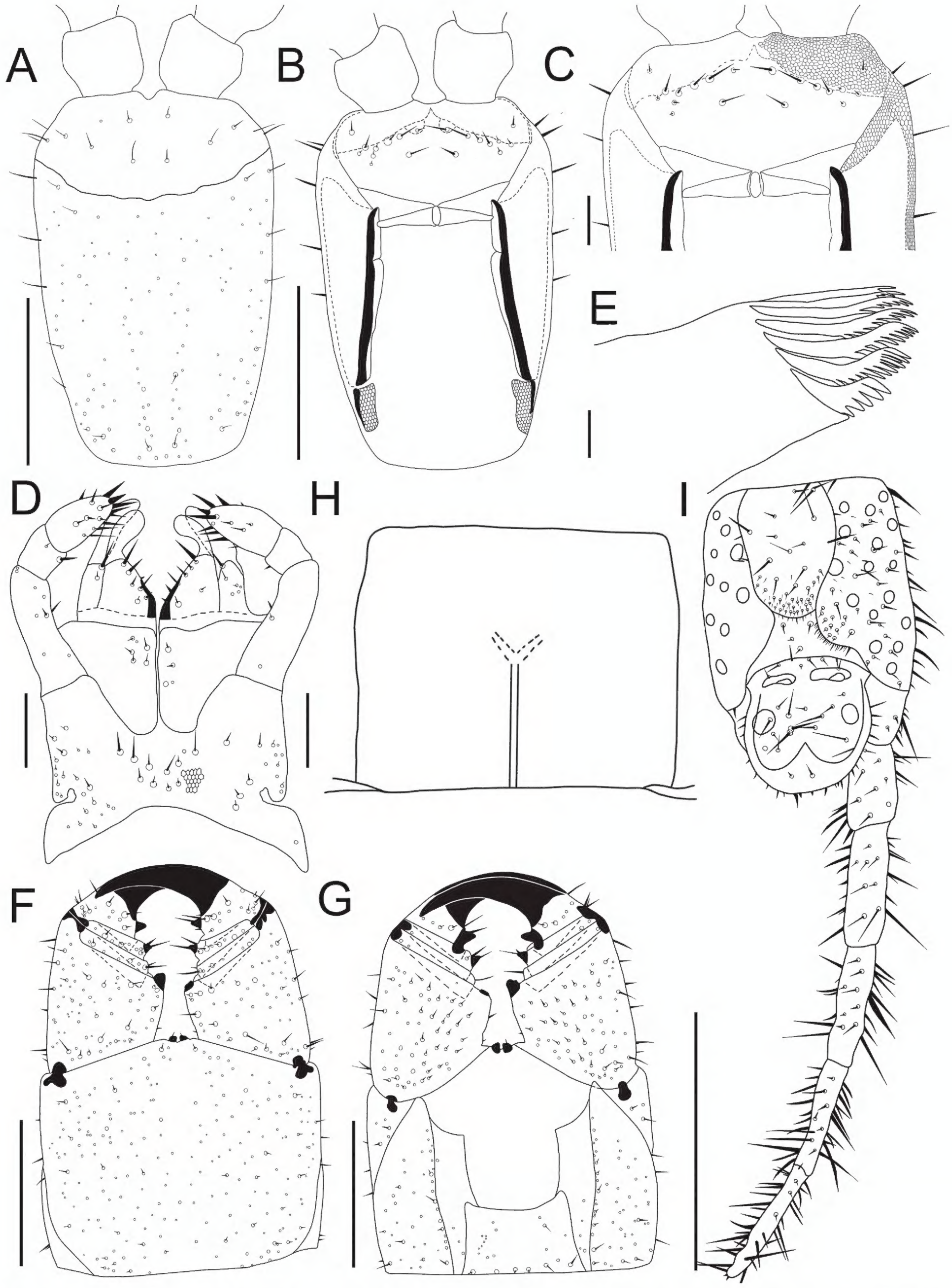

Figure 3. *Tygarrup tridentatus* sp. nov., holotype. **A.** Cephalic plate, dorsal; **B.** Cephalic plate, ventral (maxillary complex removed); **C.** Clypeus, ventral (maxillary complex removed); **D.** Maxillary complex, ventral; **E.** Mandible, ventral; **F.** Forcipular segment, ventral; **G.** Forcipular segment, dorsal; **H.** Seventh sternum of leg-bearing segment, ventral; **I.** Ultimate leg-bearing segment and left leg, ventral. Scale bars: 500 μm (**A, B, F, G, I**); 100 μm (**C, D, H**); 25 μm (**E**).

the internal surface; article 2 of telopodite 1.3 × longer than wide, with distal setae on the internal side; article 3 ca. 2.2 × longer than wide, with distal end densely covered with setae; apical claw large and simple.

Mandible with ca. 5 well-developed and ca. 2 rudimentary pectinate lamellae; first lamella with 3 teeth, similar in size; intermediate lamellae with 6–7 teeth (Fig. 3E).

***Forcipular segment*:** Coxosternite 1.2 × wider than long, anterior margin with a pair of small teeth (Fig. 3F); scapular points of pleura surpass the anterior margin of coxosternite. Forcipular trochanteroprefemur about 1.3 × longer than wide, with a prominent distal tooth, femur without teeth, tibia and tarsungulum each with a well-developed tooth (Fig. 3G).

***Leg-bearing segments*:** A total of 45 leg-bearing segments. Sternal sulcus bifurcate, faintly impressed, with an acute angle (Fig. 3H); sternal pores present on males, absent on females.

Ultimate leg-bearing segment densely setose. Tergite sub-rectangular, 1.6 × longer than wide. Coxopleuron about 1.1 × longer than wide and 1.7 × longer than ultimate sternite. Ca. 13–22 coxal pores on ventral and lateral sides of each coxopleuron, the innermost two or three pores usually larger than others (Fig. 3I). The ultimate leg telopodite not swollen, with scattered setae, without pretarsus.

Postpedal segments densely setose in both sexes. Male gonopods bi-articulate, narrow, and separated by a conical projection. Female gonopods inconspicuous bi-articulate, subtriangular (Fig. 3I). Anal pores present on each ventro-lateral side of postpedal segments.

Etymology. Latin: *tridentatus* = trident. The new species name refers to its forcipular trochanteroprefemur, tibia, and tarsungulum, each with a well-developed tooth. We suggest the Chinese common name as "三齿地蜈蚣".

Distribution. China (Xizang).

Remarks. This new species resembles *Tygarrup poriger* (Verhoeff, 1942) in possessing a tooth on the dorsal base of the forcipular tarsungulum. However, it is distinct from *T. poriger* by the presence of a well-developed tooth on the forcipular femur (Figs 1C, 3F).

Tygarrup cerrus Jiang & Huang, sp. nov.

https://zoobank.org/35956858-705E-46F1-A5D5-34D5477FD794

Figs 1D–F, 4

Material examined. ***Holotype.*** •♀ (CMMI 20240307017D), China, Xizang Autonomous Regions, Bomi County, Qingduo town (30.0946°N, 95.7031°E), 2850 m asl., 7.iii.2024, leg. Chao Jiang.

Paratypes. •6♀♀ 7♂♂ (CMMI 20240307011D–016D, 018D–024D), same as holotype.

Diagnosis. A *Tygarrup* species with 45 leg-bearing segments. Body length of adult reaches 3.6 cm. Transverse suture curved. Clypeal setae 9–12 pairs. Forcipular trochanteroprefemur and tibia, each with a small tubercle. Cerrus present as two lateral groups of setae. Sternal pores present in males only.

Description. Maximum length of male 3.6 cm and female 3.4 cm.

Color (of preserved specimens in alcohol): head and forcipular segment dark red, trunk and legs yellow, with dark patches along the trunk (Fig. 1D–F).

Cephalic plate 1.5 × longer than the widest. Transverse suture rounded. Lateral margins nearly straight and convergent backwards, anterior margin convex, with a median incision, posterior margin rounded. Setae arranged nearly symmetrically (Fig. 4A).

Clypeus 2.1 × wider than long (Fig. 4B). Clypeus with an entire plagula covering most of the clypeus, areolation only present along the anterior margin of the head; clypeal setae as follows: 1 pair on the areolate part, 7–10 pairs along to the anterior margin of the clypeal plagula, 1 pair on the central part of plagula (Fig. 4C).

Labrum (Fig. 4C): Mid-piece ca. 2.4 × longer than wide, posteriorly pointed and well sclerotized. Anterior ala triangular, medial margin reduced to a vertex; posterior margin of each side-piece sinuous.

Cephalic pleurite without spiculum or setae; areolate part present along anterior margin and paraclypeal suture; stilus well developed, nearly straight, with an anterior incision on each side (Fig. 4B).

First maxillae (Fig. 4D): Coxosternite 1.7 × wider than long, divided by mid-longitudinal suture, the anterior corners of coxosternum not projecting. Medial projection about 1.3 × wider than long, internal margin with several setae, distal lobe curved inward; telopodite about 3 × longer than wide, curved inward.

Second maxillae (Fig. 4D): Coxosternite undivided, ca. 1.2 × wider than long; both the anterior and posterior margins concave, lateral margins concave medially, posterior corners only slightly projecting externally; areolation on medial part, setae present along the posterior part; the foraminal process surrounding the metameric pore separated from lateral margin of coxosternite. Telopodites of the second maxillae well developed, surpassing those of the first maxillae; article 1 of the telopodite 2.8–3.2 × longer than wide, curved outward; article 2 of the telopodite ca. 1.1 × longer than wide; article 3 ca. 1.8 × longer than wide, with distal end densely covered with setae; apical claw large and simple.

Mandible with ca. 6 well-developed and ca. 2 rudimentary pectinate lamellae; the first lamella with 5 teeth, similar in size; intermediate lamellae with 11–15 teeth (Fig. 4E).

Forcipular segment: Coxosternite 1.4 × wider than long, anterior margin with a pair of truncated teeth (Fig. 4F); scapular points of pleura not reaching the anterior margin of coxosternite (Fig. 4G). Cerrus present as two lateral groups of setae (Fig. 4H). Forcipular trochanteroprefemur about 1.4 × longer than wide and has a small distal tubercle, femur with or without tubercle, tibia with a small pointed tubercle, tarsungulum without tubercle (Fig. 4G).

Leg-bearing segments. A total of 45 leg-bearing segments. Sternal sulcus bifurcate, faintly impressed, with an acute angle (Fig. 4I); sternal pores present on males, absent on females.

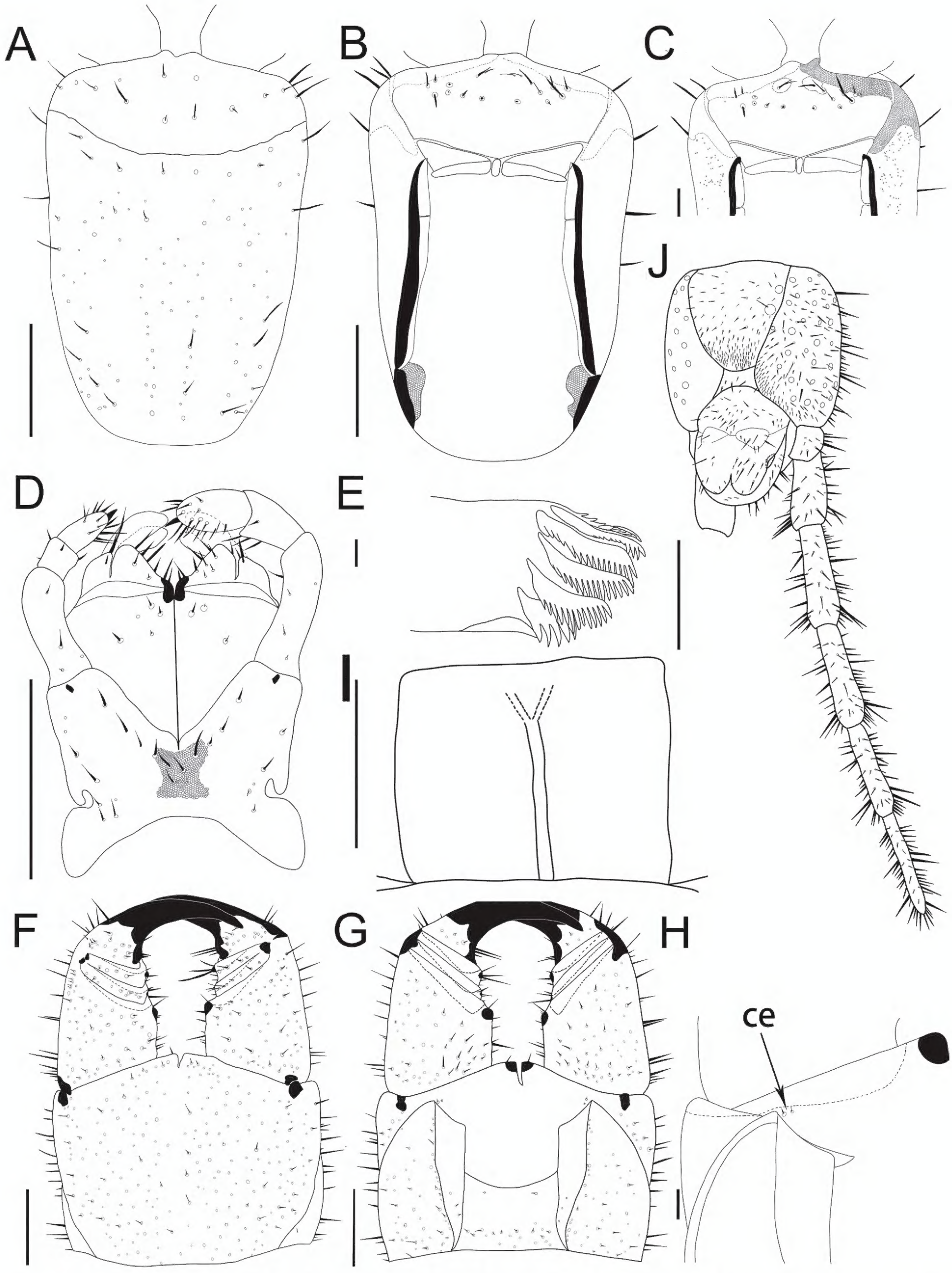

Figure 4. *Tygarrup cerrus* sp. nov., holotype. **A.** Cephalic plate, dorsal; **B.** Cephalic plate, ventral (maxillary complex removed); **C.** Clypeus, ventral (maxillary complex removed); **D.** Maxillary complex, ventral; **E.** Mandible, ventral; **F.** Forcipular segment, ventral; **G.** Forcipular segment, dorsal; **H.** Part of forcipular segment, dorsal; **I.** Seventh sternum of leg-bearing segment, ventral; **J.** Ultimate leg-bearing segment and left leg, ventral. Abbreviations: ce – cerrus. Scale bars: 500 µm (**A, B, D, F, G, I, J**); 100 µm (**C, H**); 25 µm (**E**).

Ultimate leg-bearing segment densely setose. Tergite sub-rectangular, 1.4 × longer than wide. Coxopleuron about 0.9 × longer than wide and 1.5 × longer than ultimate sternite. Ca. 30–60 coxal pores on ventral and lateral sides of each coxopleuron, the innermost two or three pores usually larger than others (Fig. 4J). The ultimate leg telopodite not swollen, with scattered setae, without pretarsus.

Postpedal segments densely setose for both sexes. Male gonopods bi-articulate, narrow, and separated by a conical projection. Female gonopods simple, subtriangular, and touching each other at their bases (Fig. 4J). Anal pores present on each ventro-lateral side of postpedal segments.

Etymology. The new species name refers to the presence of a paired lateral group of setae on the dorsal side of the forcipular coxosternite, termed 'cerrus' by Crabill (1970). We suggest the Chinese common name as "织地蜈蚣".

Distribution. China (Xizang).

Remarks. In mecistocephalids, the presence of a cerrus is a consistent character observed in several species, particularly within the genera *Dicellophilus* Cook, 1896, *Takashimaia* Miyosi, 1955, *Proterotaiwanella* Bonato, Foddai & Minelli, 2002, *Krateraspis* Lignau, 1929, and some species of *Mecistocephalus* Newport, 1843 (Bonato et al. 2002, 2003, 2010b; Uliana et al. 2007; Dyachkov and Bonato 2022; Pan et al. 2024). However, there have been no reports of the presence of a cerrus in any species of *Tygarrup* to date. The discovery of cerrus in the newly described species *T. cerrus* sp. nov. offers a further understanding of the evolutionary development of this structure within the Mecistocephalidae as well as phylogenetic relationships among the mecistocephalid genera.

Tygarrup multiporus Jiang & Huang, sp. nov.

https://zoobank.org/5A9F733C-5880-4647-A377-706428584E8D

Figs 1G–I, 5

Material examined. ***Holotype.*** • ♀ (CMMI 20240312003D), China, Xizang Autonomous Regions, Medog County, near Deergong village (29.1810°N, 95.1439°E), 1710 m asl., 12.iii.2024, leg. Chao Jiang.

Paratypes. • 2♀♀ (CMMI 20240309012D, 20240311003D), China, Xizang Autonomous Regions, Medog County, near Renqingbensi Temple (29.3075°N, 95.3573°E), 1920 m asl., 9–11.iii.2024, leg. Chao Jiang.

Diagnosis. A *Tygarrup* species with 45 leg-bearing segments. Body length of adult reaches 3.4 cm. Cephalic frontal plate postero-lateral corner bears 10–20 pore-like sensilla. Clypeal plagula with 6 pairs of setae on antero-medial and several pore-like sensilla on antero-lateral corners. Forcipular trochanteroprefemur and tibia, each with a tubercle, femur and tarsungulum without tubercles. Sternal pores present in males only.

Description. Maximum length 3.4 cm.

Color (of preserved specimens in alcohol): Head and forcipular segment reddish-brown, trunk and legs homogeneously yellow, without dark patches (Fig. 1G–I).

Cephalic plate (Fig. 5A) 1.5 × longer than the widest. Transverse suture curved, forms a backward-directed angle medially. Lateral margins sinuous, convergent backwards strongly, anterior margin convex, with a median incision, posterior margin rounded. Frontal plate postero-lateral corner bears 10–20 pore-like sensilla. Setae arranged nearly symmetrically.

Clypeus 2 × wider than long. Clypeus with an entire plagula covering most of the clypeus, areolation only present along the anterior margin of the head; clypeal setae as follows: 1 pair on the areolate part, 2 pairs along the anterior margin of the clypeal plagula, 2 pairs on the antero-medial part inside a large insula, 1 pair on the central part of plagula. Five to eight pore-like sensilla on each antero-lateral corner (Fig. 5B).

***Labrum*:** Mid-piece ca. 2.1 × longer than wide, posteriorly pointed and well sclerotized. Anterior ala triangular, medial margin reduced, distinct shorter than lateral margin; posterior margin of each side-piece sinuous (Fig. 5B).

Cephalic pleurite without spiculum or setae; areolate part present along anterior margin and paraclypeal suture; stilus well developed, nearly straight, with an anterior incision on each side (Fig. 5B).

First maxillae (Fig. 5C): Coxosternite 1.9 × wider than long, divided by mid-longitudinal suture, anterior corners of coxosternum not projecting. Medial projection about 1.3 × wider than long, internal margin with several setae, distal lobe curved inward; telopodite about 2.3 × longer than wide, curved inward.

Second maxillae (Fig. 5C): Coxosternite undivided, ca. 1.4 × wider than long; both the anterior and posterior margins concave, lateral margins concave medially, posterior corners only slightly projecting externally; areolation on medial part, setae present along the posterior part; the foraminal process surrounding the metameric pore separated from lateral margin of coxosternite. Telopodites of the second maxillae well developed, surpassing those of the first maxillae; article 1 of the telopodite 2.9–3.5 × longer than wide, curved outward; article 2 of the telopodite ca. 1.4 × longer than wide; article 3 ca. 2.3 × longer than wide, with distal end densely covered with setae; apical claw large and simple.

Mandible with ca. 6–7 well-developed and ca. 2 rudimentary pectinate lamellae; the first lamella with 4 teeth, similar in size; intermediate lamellae with 9–13 teeth (Fig. 5D).

***Forcipular segment*:** Coxosternite 1.4 × wider than long, anterior margin with a pair of truncated teeth (Fig. 5E); scapular points of pleura not reaching the anterior margin of coxosternite (Fig. 5F). Forcipular trochanteroprefemur about 1.3 × longer than wide and has a conical distal tooth, intermediate articles each with a small tooth, tarsungulum without tooth.

Leg-bearing segments. A total of 45 leg-bearing segments. Sternal sulcus bifurcate faintly impressed, with an acute angle (Fig. 5G); sternal pores present on males, absent on females.

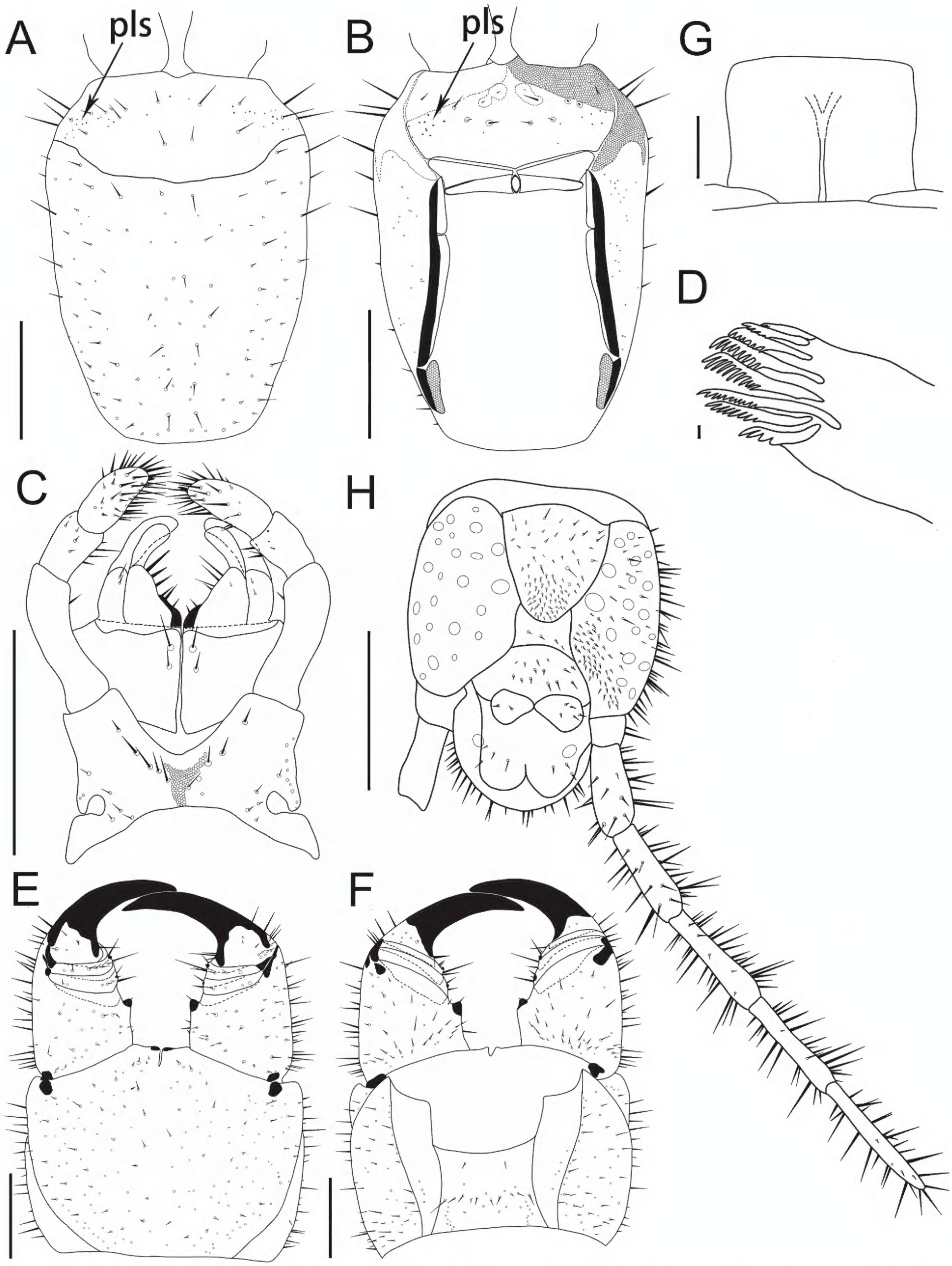

Figure 5. *Tygarrup multiporus* sp. nov., holotype. **A.** Cephalic plate, dorsal; **B.** Cephalic plate, ventral (maxillary complex removed); **C.** Maxillary complex, ventral; **D.** Mandible, ventral; **E.** Forcipular segment, ventral; **F.** Forcipular segment, dorsal; **G.** Seventh sternum of leg-bearing segment, ventral; **H.** Ultimate leg-bearing segment and left leg, ventral. Abbreviations: pls – pore-like sensilla. Scale bars: 500 μm (**A–C, E–H**); 25 μm (**D**).

Ultimate leg-bearing segment densely setose. Tergite sub-rectangular, 1.1 × longer than wide. Coxopleuron about 0.8 × longer than wide and 1.7 × longer than ultimate sternite. Ca. 20–28 coxal pores on ventral and lateral sides of each coxopleuron, the innermost two pores usually larger than others (Fig. 5H). The ultimate leg telopodite not swollen, with scattered setae, without pretarsus.

Postpedal segments densely setose for both sexes. Male gonopods bi-articulate, narrow, and separated by a conic projection. Female gonopods simple, subtriangular, and touching each other at their bases (Fig. 5H). Anal pores present on each ventro-lateral side of postpedal segments.

Etymology. The new species name refers to the presence of many pore-like sensilla on cephalic capsule and clypeus plagula. We suggest the Chinese common name as "多孔地蜈蚣".

Distribution. China (Xizang).

Remarks. This new species is distinguished from all the hitherto known *Tygarrup* species by the presence of pore-like sensilla on its clypeal plagula and cephalic plate, a character not previously documented in this genus. However, when Titova (1983) described *T. crassignathus* Titova, 1983, and *T. singaporiensis* Verhoeff, 1937, the illustrations of the clypeal plagula (Titova 1983: figs 5, 10) showed numerous dense small spots, which are inferred herein to possibly be pore-like sensilla.

The new species is further distinguished from *T. crassignathus* by the absence of an incrassate forcipular trochanteroprefemurand a large distal tooth, features present in the latter (Titova 1983: fig. 7). Instead, the new species possesses a forcipular trochanteroprefemurtooth of typical dimensions. The new species can also be distinguished from *T. singaporiensis* by the number of clypeus plagula pore-like sensilla (more than 5–10 on each side, confined to the antero-lateral corner vs. more than 50 on each side, extending from the antero-lateral corner to the paramedian setae) and the clypeus setae (2 lateral and 6 paramedian setae vs. 10 or 11 lateral and 6 or fewer paramedian setae) (Titova 1983: fig. 9).

Tygarrup fimbriatus Jiang & Huang, sp. nov.

https://zoobank.org/60EDCB5D-4A74-4810-9394-601036025430

Figs 2A–C, 6

Material examined. ***Holotype.*** • ♀ (CMMI 20240311004D), China, Xizang Autonomous Regions, Medog County, Hanmi (29.3619°N, 95.1337°E), 2000 m asl., 11.iii.2024, leg. Chao Jiang.

Paratypes. • 3♀♀ 4♂♂, (CMMI 20240311005D–007D, 009D–012D), same as holotype.

Other materials. • 1♀ (CMMI 20240311013D), China, Xizang Autonomous Regions, Medog County, Beibeng village (29.2488°N, 95.1901°E), 920 m asl., 11.iii.2024, leg. Chao Jiang, 1♀ (CMMI 20240313011D), Damu village (29.4864°N, 95.4547°E), 1350 m asl., 8.iii.2024, leg. Chao Jiang; • 9♀♀ 4♂♂, (CMMI 20240307001D–009D, 20240313001D–004D), Bomi County, Yigong village, near Tongmai Bridge (30.0989°N, 95.0673°E), 2050 m asl., 7–13.iii.2024, leg. Chao Jiang, 1♀ (CMMI 20240308004D), Gu village, G319 National Road (29.9973°N, 95.3092°E), 2405 m asl., 13.iii.2024, leg. Chao Jiang.

Diagnosis. A *Tygarrup* species with 45 leg-bearing segments. Body length of adult reaches 5.5 cm. Cephalic frontal plate postero-lateral corner bears 10–20 pore-like sensilla. Clypeal plagula with 9–12 pairs of setae along the anterior margin and several pore-like sensilla on antero-lateral corners. Labral posterior alae fringed with hair-like projections along the posterior margins. Forcipular trochanteroprefemur with a tooth, tarsungulum without tubercle. Sternal pores present in males only.

Description. Maximum length of male 4.1 cm, and of females, 5.5 cm.

Color (of preserved specimens in alcohol): Head and forcipular segment reddish-brown, trunk and legs homogeneously yellow, without dark patches (Fig. 2A–C).

Cephalic plate (Fig. 6A) 1.4 × longer than the widest. Transverse suture rounded. Lateral margins sinuous, convergent backwards, anterior margin convex, with a median incision, posterior margin rounded. Frontal plate postero-lateral corner bears 10–20 pore-like sensilla. Setae arranged nearly symmetrically.

Clypeus (Fig. 6B) 2.1 × wider than long. Clypeus with an entire plagula covering most of the clypeus, areolation only present along the anterior margin of the head; clypeal setae as follows: 1 pair on the areolate part, 4 (considered as damaged and repaired in left side of holotype)–10 pairs along the anterior margin of the clypeal plagula, 1 pair on the central part of plagula. Six to twelve pore-like sensilla on each antero-lateral corner.

***Labrum*:** Mid-piece ca. 1.8 × longer than wide, posteriorly pointed and well sclerotized. Anterior ala triangular; medial margin reduced, distinct shorter than lateral margin; posterior margin of each side-piece sinuous (Fig. 6B); posterior alae fringed with hair-like projections along the posterior margins (Fig. 6C).

Cephalic pleurite without spiculum or setae; areolate part present along anterior margin and paraclypeal suture; stilus well developed, nearly straight, with an anterior incision on each side (Fig. 6B).

First maxillae (Fig. 6D): Coxosternite 1.7 × wider than long, divided by mid-longitudinal suture, anterior corners of coxosternum not projecting. Medial projection about 1.4 × wider than long, internal margin with several setae, distal lobe curved inward; telopodite about 2.3 × longer than wide, curved inward.

Second maxillae (Fig. 6D): Coxosternite undivided, ca. 1.4 × wider than long; both the anterior and posterior margins concave, lateral margins concave medially, posterior corners only slightly projecting externally; areolation on medial part, setae present along the posterior part; the foraminal process surrounding the metameric pore separated from lateral margin of coxosternite. Telopodites of the second maxillae well developed, surpassing those of the first maxillae;

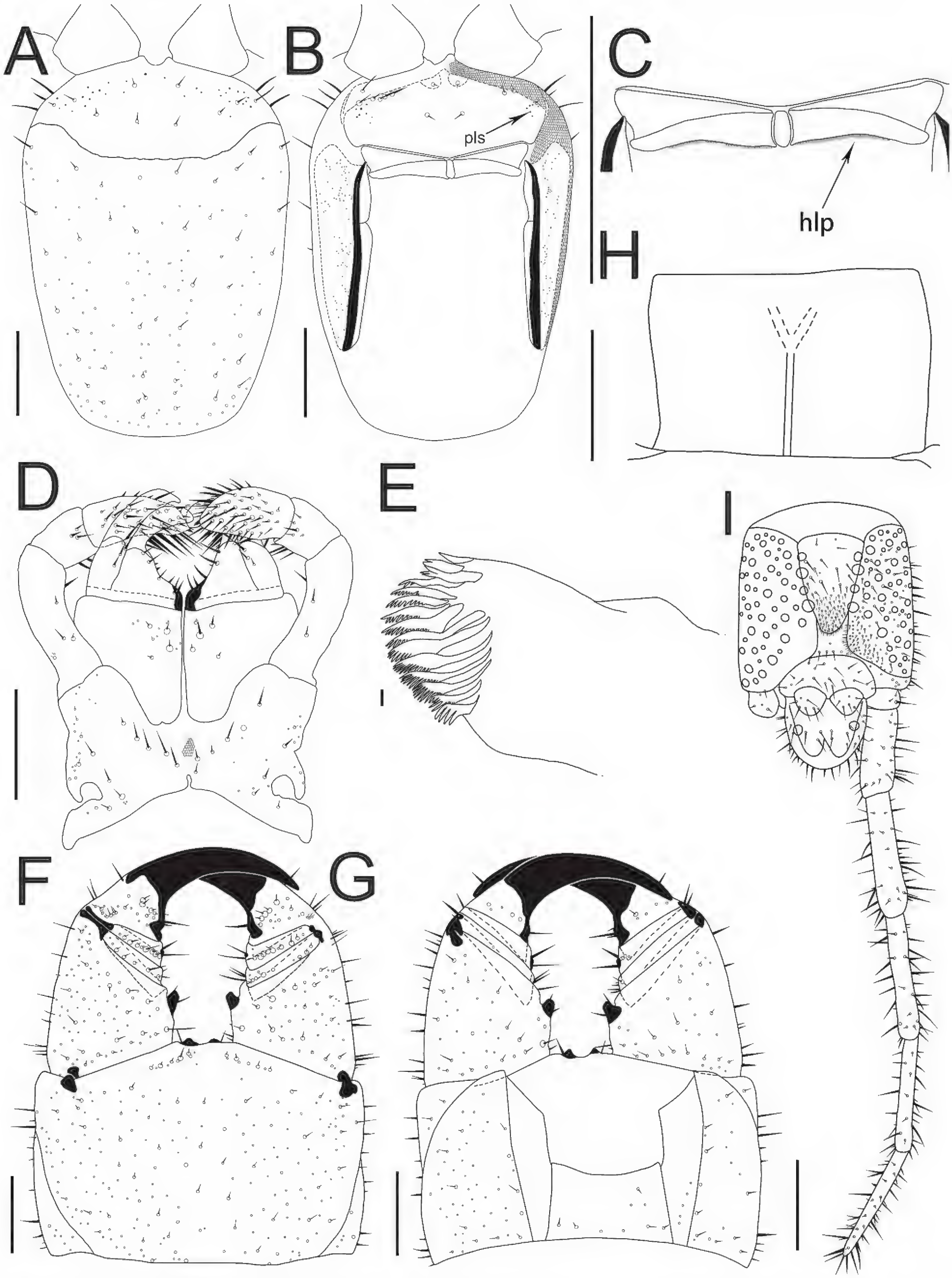

Figure 6. *Tygarrup fimbriatus* sp. nov., holotype. **A.** Cephalic plate, dorsal; **B.** Cephalic plate, ventral (maxillary complex removed); **C.** Labrum, dorsal; **D.** Maxillary complex, ventral; **E.** Mandible, ventral; **F.** Forcipular segment, ventral; **G.** Forcipular segment, dorsal; **H.** Seventh sternum of leg-bearing segment, ventral; **I.** Ultimate leg-bearing segment and left leg, ventral. Abbreviations: pls – pore-like sensilla, hlp – hair-like projections. Scale bars: 500 µm (**A, B, D, F–I**); 250 µm (**C**); 25 µm (**E**).

article 1 of the telopodite 3–3.3 × longer than wide, curved outward; article 2 of the telopodite ca. 1.1 × longer than wide; article 3 ca. 1.8 × longer than wide, with distal end densely covered with setae; apical claw simple.

Mandible with ca. 10–12 well-developed and ca. 2 rudimentary pectinate lamellae; the first lamella with 4–5 teeth, similar in size; intermediate lamellae with 9–12 teeth (Fig. 6E).

***Forcipular segment*:** Coxosternite 1.4 × wider than long, anterior margin with a pair of truncated teeth (Fig. 6F); scapular points of pleura reaching the anterior margin of coxosternite (Fig. 6G). Forcipular trochantero-prefemur about 1.4 × longer than wide and has a conical distal tooth (Bomi population) or a truncated distal tooth (Medog populations), intermediate articles with or without tubercle, tarsungulum without tubercle.

***Leg-bearing segments*:** A total of 45 leg-bearing segments. Sternal sulcus bifurcate faintly impressed, with an acute angle (Fig. 6H); sternal pores present on males, absent on females.

Ultimate leg-bearing segment densely setose. Tergite sub-rectangular, 1.1 × longer than wide. Coxopleuron as long as wide and 1.7 × longer than sternite. Ca. 50–80 coxal pores on ventral and lateral sides of each coxopleuron, the innermost two to four pores usually larger than others (Fig. 6I). The ultimate leg telopodite not swollen, with scattered setae, without pretarsus.

Postpedal segments densely setose for both sexes. Male gonopods bi-articulate, narrow, and separated by a conical projection. Female gonopods simple, sub-triangular, and touching each other at their bases (Fig. 6I). Anal pores present on each ventro-lateral side of postpedal segments.

Etymology. Latin *fimbr* = fiber; the new species name refers to the presence of hair-like projections along the posterior margins of the labral posterior alae. We suggest the Chinese common name as "流苏地蜈蚣".

Distribution. China (Xizang).

Remarks. This new species resembles *T. multiporus* sp. nov., especially in the presence of pore-like sensilla on the clypeal plagula and cephalic plate. However, it can be distinguished from the latter by several distinct features: it possesses 9–12 pairs of setae along the anterior margin of the clypeal plagula, has hair-like projections along the posterior margins of the labral posterior alae, trunk along with dark patches, and exhibits a larger body size and elevated coxopleural pore numbers. In contrast, *T. multiporus* sp. nov. has only 3–4 pairs of setae along the anterior margin of the clypeal plagula, smooth posterior margins on the labral posterior alae, and a homogeneously yellow trunk without dark patches.

The presence of hair-like projections along the posterior margins of the labral posterior alae, a character typically associated with the genus *Dicellophilus* Cook, 1896, is reported in the genus *Tygarrup* for the first time. These projections are clearly shorter in *Tygarrup* than in *Dicellophilus* (Bonato et al. 2010b; Tsukamoto and Eguchi 2024). This distinction highlights the unique adaptation of the new species within the *Tygarrup* genus.

Tygarrup poriger (Verhoeff, 1942)

Figs 2D–F, 7

Brahmaputrus poriger Verhoeff, 1942: 51–52, figs 15–21.

Tygarrup poriger: Crabill 1968: 286–287.

Tygarrup nepalensis Shinohara, 1965: 303–306, figs 1–11. syn. nov.

Material examined. • 12 spms (CMMI 20240309001D, -003D, -005D, -008D, -013D, -014D, -016D, -018D–020D, 20240311001D, 20240311002D), China, Xizang Autonomous Regions, Medog County, near Renqingbensi Temple (29.3075°N, 95.3573°E), 1920 m asl., 9–11.iii.2024, leg. Chao Jiang, • 10 spms (CMMI 20240310002D, -006D–009D, -011D, -014D, 20240312005D, -007D, -013D) near Deergong village (29.1810°N, 95.1439°E), 1710 m asl., 10–12.iii.2024, leg. Chao Jiang, • 3 spms (CMMI 20240310016D, -017D, -019D), Shuwang Forestry (29.1946°N, 95.1920°E), 1780 m asl., 10.iii.2024, leg. Chao Jiang.

Diagnosis. A *Tygarrup* species with 45 leg-bearing segments. Clypeal setae 7–9 pairs. Forcipular trochanteroprefemur and tibia, each with a tooth, femur without, tarsungulum with a triangular tooth on the dorsal base. Sternal pores present in males only.

Re-description. Maximum length of male 3.6 cm and female 3.3 cm.

Color (of preserved specimens in alcohol): head and forcipular segment dark red, trunk and legs yellow, with dark patches along the trunk (Fig. 2D–F).

Cephalic plate (Fig. 7A) 1.5 × longer than the widest. Transverse suture rounded. Lateral margins nearly straight and convergent backwards, anterior margin convex, with a median incision, posterior margin rounded. Setae arranged nearly symmetrically.

Clypeus 2 × wider than long (Fig. 7B). Clypeus with an entire plagula covering most of the clypeus, areolation only present along the anterior margin of the head; clypeal setae as follows: 1 pair on the areolate part, 3–5 pairs along the anterior margin of the clypeal plagula, 2 pairs on the antero-medial part inside a large insula, and 1 pair on the central part of plagula (Fig. 7C).

Labrum (Fig. 7C): Mid-piece ca. 1.7 × longer than wide, posteriorly pointed and well sclerotized. anterior ala triangular, medial margin reduced to a vertex; posterior margin of each side-piece sinuous.

Cephalic pleurite without spiculum or setae; areolate part present along anterior margin and paraclypeal suture; stilus well developed, nearly straight, with an anterior incision on each side (Fig. 7B).

First maxillae (Fig. 7D): Coxosternite 1.8 × wider than long, divided by mid-longitudinal suture, anterior corners of coxosternum not projecting. Medial projection about 1.2 × wider than long, internal margin with several setae, distal lobe curved inward; telopodite about 2.1 × longer than wide, curved inward.

Second maxillae (Fig. 7D): Coxosternite undivided, ca. 1.4 × wider than long; both the anterior and posterior margins concave, lateral margins concave medially, posterior corners only slightly projecting externally;

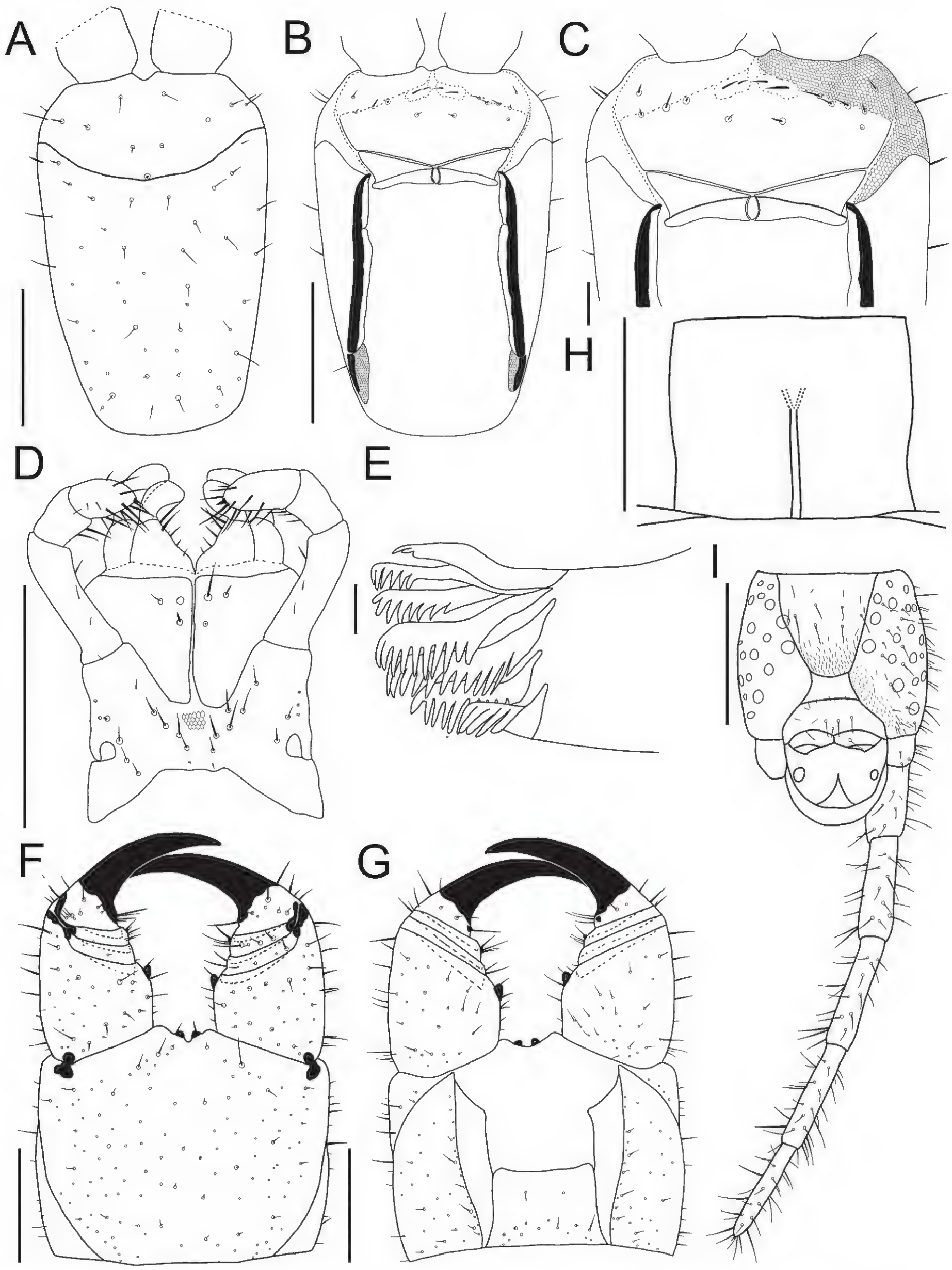

Figure 7. *Tygarrup poriger* (Verhoeff, 1942) (spm. CMMI 20240309001D). **A.** Cephalic plate, dorsal; **B.** Cephalic plate, ventral (maxillary complex removed); **C.** Clypeus, ventral (maxillary complex removed); **D.** Maxillary complex, ventral; **E.** Mandible, ventral; **F.** Forcipular segment, ventral; **G.** Forcipular segment, dorsal; **H.** Seventh sternum of leg-bearing segment, ventral; **I.** Ultimate leg-bearing segment and left leg, ventral. Scale bars: 500 µm (**A, B, D, F–I**); 100 µm (**C**); 25 µm (**E**).

areolation on medial part, setae present along the posterior part; the foraminal process surrounding the metameric pore separated from lateral margin of coxosternite. Telopodites of the second maxillae developed, surpassing those of the first maxillae when stretched; article 1 of the telopodite ca. 3.1 × longer than wide, curved outward;

article 2 of the telopodite ca. 1.6 × longer than wide; article 3 ca. 2.2 × longer than wide, with distal end densely covered with setae; apical claw large and simple.

Mandible with ca. 7 well-developed and ca. 2 rudimentary pectinate lamellae; the first lamella with 5 teeth, similar in size; intermediate lamellae with 9–12 teeth (Fig. 7E).

***Forcipular segment*:** Coxosternite 1.3 × wider than long, anterior margin with a pair of truncated teeth (Fig. 7F); scapular points of pleura reaching the anterior margin of coxosternite (Fig. 7G). Forcipular trochanteroprefemur about 1.3 × longer than wide and has a prominent distal tooth, femur with or without tubercle, tibia with a small pointed tubercle, tarsungulum with a triangular tooth on dorsal base.

***Leg-bearing segments*:** A total of 45 leg-bearing segments. Sternal sulcus bifurcate faintly impressed, with an acute angle (Fig. 7H); sternal pores present on males, absent on females.

Ultimate leg-bearing segment densely setose. Tergite sub-rectangular, 1.1 × longer than wide. Coxopleuron about 0.9 × longer than wide and 1.6 × longer than sternite. Ca. 20–35 coxal pores on ventral and lateral sides of each coxopleuron, the innermost two pores usually larger than others (Fig. 7I). The ultimate leg telopoditenot swollen, with scattered setae, without pretarsus.

Postpedal segments densely setose for both sexes. Male gonopods bi-articulate, narrow, and separated by a conical projection. Female gonopods inconspicuous bi-articulate, subtriangular, and touching each other at their bases (Fig. 7I). Anal pores present on each ventro-lateral side of postpedal segments.

Distribution. China (Xizang), Nepal.

Remarks. Verhoeff (1942) originally described a new genus, *Brahmaputrus*, and type species, *B. poriger*, from Shigatse, Xizang, of China, with 45 leg-bearing segments and males with sternal pores. Crabill (1968) considered the genus *Brahmaputrus* Verhoeff, 1942, as a synonym of *Tygarrup* Chamberlin, 1914. This species differs from other *Tygarrup* species for its forcipular trochanteroprefemur with a tooth, femur without, and tarsungulum with a tooth on dorsal base.

Shinohara (1965) originally described a *Tygarrup* species, *T. nepalensis*, based on 28 specimens from Ralwaling Himal, East Nepal. However, illustrations given by Shinohara (1965: figs 5–11) show minor variation with *T. poriger* sensu Verhoeff (1942: figs 15–21) and the present study (Fig. 7) in the clypeal setae, forcipular articles, maxillae, shape of the ultimate leg-bearing segment, and coxal pore numbers, particularly the dorsal tooth on the forcipular tarsungulum. Therefore, *Tygarrup nepalensis* Shinohara, 1965, is treated as a junior synonym of *Tygarrup poriger* (Verhoeff, 1942).

Tygarrup muminabadicus Titova, 1965

Figs 2G–I, 8

Tygarrup muminabadicus Titova, 1965: 871–876, figs 1, 2; Bonato et al. 2003: figs 8C, 9E, 10A, 13B; Dyachkov 2020: 80, 2022:75, figs 5–11.

Material examined. • 3 spms, (CMMI 20220525124, -126, -128), China, Xizang Autonomous Regions, Jilong County, near Rukaer (28.4481°N, 85.2467°E), 2970 m asl., 25.v.2022, leg. Xiaoxia Tian; • 2 spms (CMMI 20210705142, CMMI 20210705144), Luozha County, Lakang town, (28.1125°N, 91.1251°E), 3230 m asl., 5.vii.2022, leg. Chao Jiang; • 1 spms (CMMI 20210708102), Jiacha County, Anrao town (29.1420°N, 92.5829°E), 3240 m asl., 8.vii.2021, leg. Chao Jiang; 1 spm (CMMI 20220620103), Linzhi, Bayi district, Sejilashan Mt. (29.6213°N, 94.6514°E), 20.vi.2022, leg. Xiaoxia Tian, • 5 spms (CMMI 20201013119D–123D), Fuqing Road, 13.x.2020, leg. Chao Jiang, • 2 spms (CMMI 20201013137, CMMI 20201013142), Birishenshan Mt., 13.x.2020, leg. Chao Jiang; 1 spm (CMMI 20240310018D), Medog County, Shuwang Forestry (29.1946°N, 95.1920°E), 1780 m asl., 10.iii.2024, leg. Chao Jiang, • 7 spms (CMMI 20240310001D, -003D, -004D, -015D, CMMI 20240312001D, -008D, -009D), near Deergong village (29.1810°N, 95.1439°E), 1710 m asl., 10–12.iii.2024, leg. Chao Jiang.

Diagnosis. A *Tygarrup* species with 45 leg-bearing segments. Body length of adult reaches 5 cm. Clypeal plagula with 6–9 pairs of setae along the anterior margin; plagula without pore-like sensilla. Labral posterior alae posterior margins smooth, without hair-like projection. Forcipular trochanteroprefemur with a tooth, femur, and tarsungulum without tooth. Sternal pores present in males only. Coxopleuron with ca. 40–70 coxal pores. Female gonopods unarticulated.

Distribution. China (Xizang), Tajikistan, Kashmir.

Remarks. Specimens from Xizang could be assigned only tentatively to *T. muminabadicus*, as they are largely consistent with the original description (Titova 1965) and topotypes (Dyachkov 2022) of this species, only differing for a more inward-curved first maxillary telopodite (clavate in the original illustration) and for the elevated number of coxal pores on coxopleuron. This species has been previously documented in Tajikistan (Titova 1965; Dyachkov 2020, 2022) and Kashmir (Bonato et al. 2003) and is now reported for the first time in the Chinese fauna. The morphological characters of Chinese specimens are delineated through the accompanying illustrations (Figs 2G–I, 8).

T. diversidens, a Himalayan species that was originally described by Silvestri (1919) as *Lamnonyx diversidens*. This description was based on numerous specimens across a wide area of the Himalayas, extending from Assam in the east to Kashmir in the west. These distributions also include two localities in Xizang (Rotung and Renging) and are considered Xizang's *Tygarrup* species. The species also has the inwardly curved first maxillary telopodite (Silvestri 1919: fig. XX5) but is distinguished from *T. muminabadicus* by having bi-articulate female gonopods (Silvestri 1919: fig. XX8). However, the original description of *T. diversidens* is very inadequate, leaving the taxonomic relationship of this nominal species with other *Tygarrup* species from the Himalayas undetermined, necessitating further investigation (Bonato and Minelli 2004).

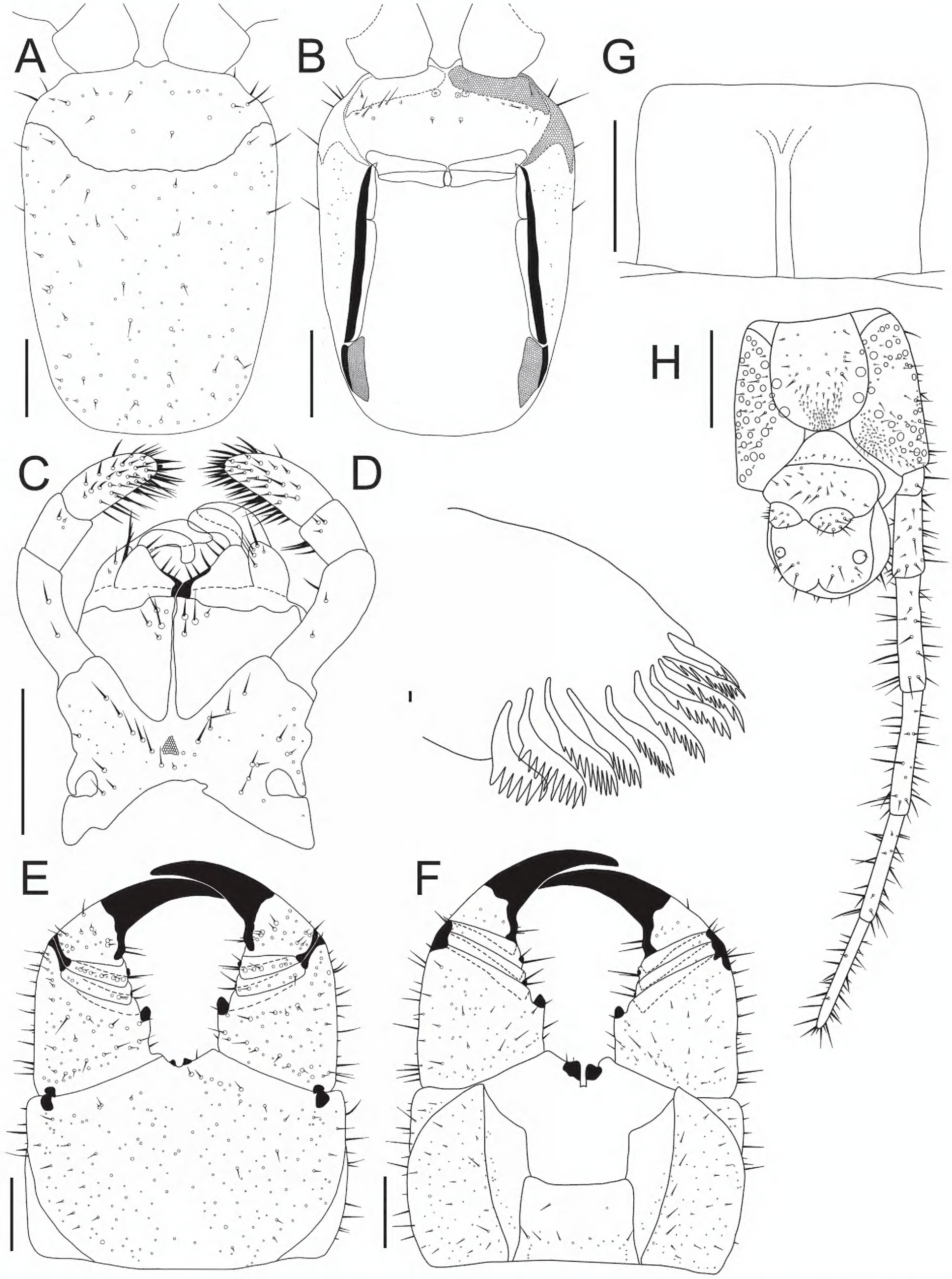

Figure 8. *Tygarrup muminabadicus* Titova, 1965 (spm. CMMI 20240310001D). **A.** Cephalic plate, dorsal; **B.** Cephalic plate, ventral (maxillary complex removed); **C.** Maxillary complex, ventral; **D.** Mandible, ventral; **E.** Forcipular segment, ventral; **F.** Forcipular segment, dorsal; **G.** Seventh sternum of leg-bearing segment, ventral; **H.** Ultimate leg-bearing segment and left leg, ventral. Scale bars: 500 μm (**A–C, E–H**); 25 μm (**D**).

Discussion

In the present study, we investigated the genus *Tygarrup* from Xizang and identified six species within the genus (Fig. 9). Certain morphological characters, such as pore-like sensilla, cerrus, and the hair-like projections along the posterior margins of the labral posterior alae, were discovered for the first time to be effective in distinguishing species within the *Tygarrup* genus for the first time. The introduction of these new morphological characters allows for a more accurate differentiation of *Tygarrup* species in Xizang, contributing to a better understanding of the diversity of soil centipede species in this region.

Tygarrup species from Xizang dwell in both tropical dry forests and alpine environments. The lowest recorded altitude for their habitat is 920 meters (*T. fimbriatus* sp. nov.), while the highest extends up to 4400 meters (*T. tridentatus* sp. nov.). Among them, *T. tridentatus* sp. nov. and *T. poriger* can inhabit both cold mountain regions and low-altitude warmer forests. In contrast, *T. cerrus* sp. nov. is found exclusively in high mountain coniferous forests at around 3000 meters in altitude. Based on our available specimens and historical records (Verhoeff 1942; Shinohara 1965), most *Tygarrup* species in Xizang live at altitudes above 1700 meters, while *Tygarrup* species in other regions predominantly inhabit forests or greenhouses below 1500 meters (Silvestri 1919; Attems 1929; Titova 1983; Bonato et al. 2004; Uliana et al. 2007; Bonato and Minelli 2010; Dyachkov 2020, 2022). Historical literatures and our results also show that the number of *Tygarrup* species in the Himalayan mountainous regions within the same scale is higher than in the northern Qinghai-Tibet Plateau region as well as in the southern tropical rainforests and Gangetic Plains (Silvestri 1919). The complexity of mountains is usually tightly associated with high biodiversity (Perrigo et al. 2020). In multiple animal and plant groups, the uplift of the Himalayas has promoted biological diversification (Xia et al. 2022; Liu et al. 2024). Therefore, the Himalayas, with their complete tropical monsoon mountain vertical natural zones ranging from lowland tropical monsoon rainforests to alpine snow zones, may have facilitated the diversification of the *Tygarrup* species in Xizang. Considering the diversity of the Himalayan ecosystem, the sampled regions available are still only fragmentary and insufficient for the diversity research of *Tygarrup*. Therefore, the faunal diversity in this region is likely still underestimated.

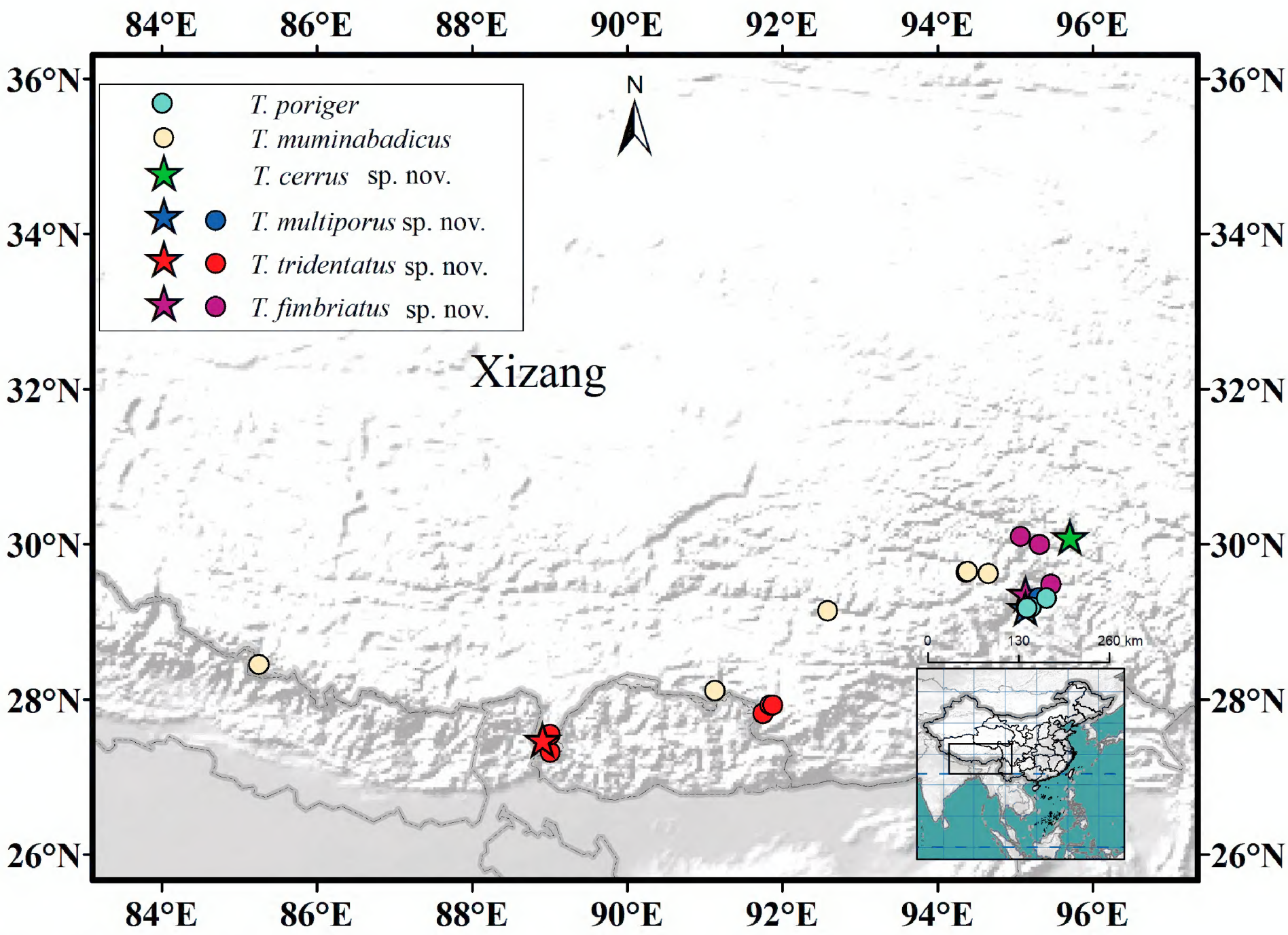

Figure 9. Collected localities of species of *Tygarrup* in Xizang of China. Stars represent type localities.

Key to the six confined *Tygarrup* species of China

1 Cerrus composed of two lateral groups of setae (Fig. 4H) ..... *T. cerrus* sp. nov.
– Cerrus absent 2
2 Antero-lateral corners of plagula evidently bear pore-like sensilla 3
– Antero-lateral corners of plagula absent pore-like sensilla 4
3 Posterior margins of labral posterior alae bear hair-like projections (Fig. 6C) ..... *T. fimbriatus* sp. nov.
– Posterior margins of labral posterior alae absent hair-like projection (Fig. 5B) ..... *T. multiporus* sp. nov.
4 Central part of plagula with ca. 15 paired setae arranged in three irregular rows (Chao et al. 2020: fig. 3) ... *T. daliensis*
– Central part of plagula with 6–11 paired setae arranged in two irregular rows 5
5 Forcipular tarsungulum with a tooth 6
– Forcipular tarsungulum without tooth (Fig. 8F) ..... *T. muminabadicus*
6 Forcipular article III and tarsungulum with a prominent pointed tooth (Fig. 3F, G) ..... *T. tridentatus* sp. nov.
– Forcipular article III with a small tubercle, tarsungulum with a triangular tooth on dorsal base (Fig. 7G) ..... *T. poriger*

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